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(54) **Sheet cutter**

(57) An apparatus for cutting sheet material comprises a drive shaft 1 having a resin-molded helical track (2, Fig 3) formed on its outer surface, and a cutter adapted to engage in the helical track (2, Fig 3) and be driven along the shaft 1 when the shaft is rotated. The part (20, Fig 6) of the cutter engaging with the track is also resin-molded to reduce noise. The track preferably comprises an outward portion and a return portion, and the cutter can cut the sheet the material while travelling on the outward portion only or on both portions. The cutter comprises a circular knife, 5a which engages with a second blade 5b to cut the sheet material therebetween. The shaft can be driven by a motor 14 through a resin-molded helical gear chain 13, 15. Preferably, the cutter includes means (33, Figs 10, 11) to direct the path of a cut portion of sheet material.

FIG. 2

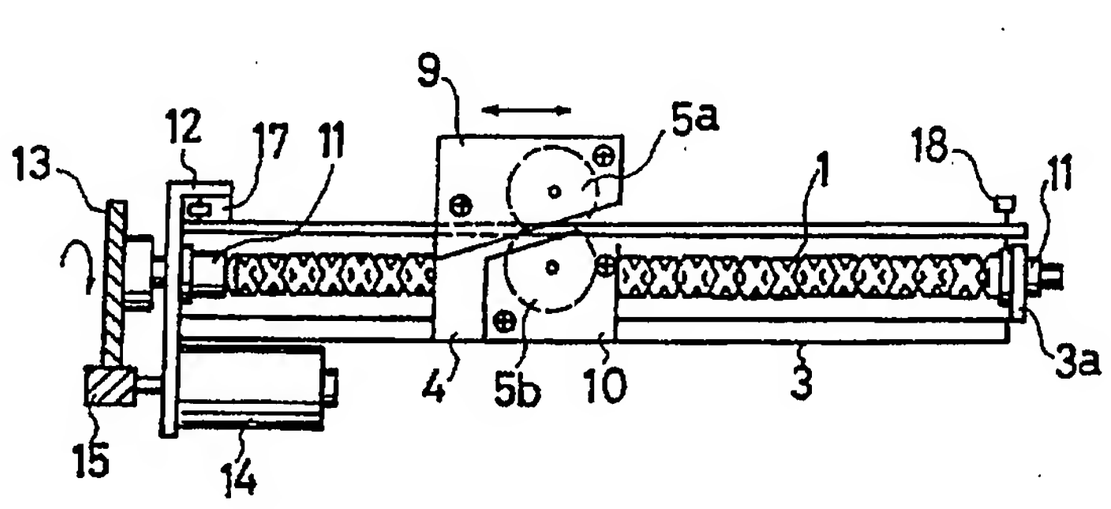

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FIG. 1

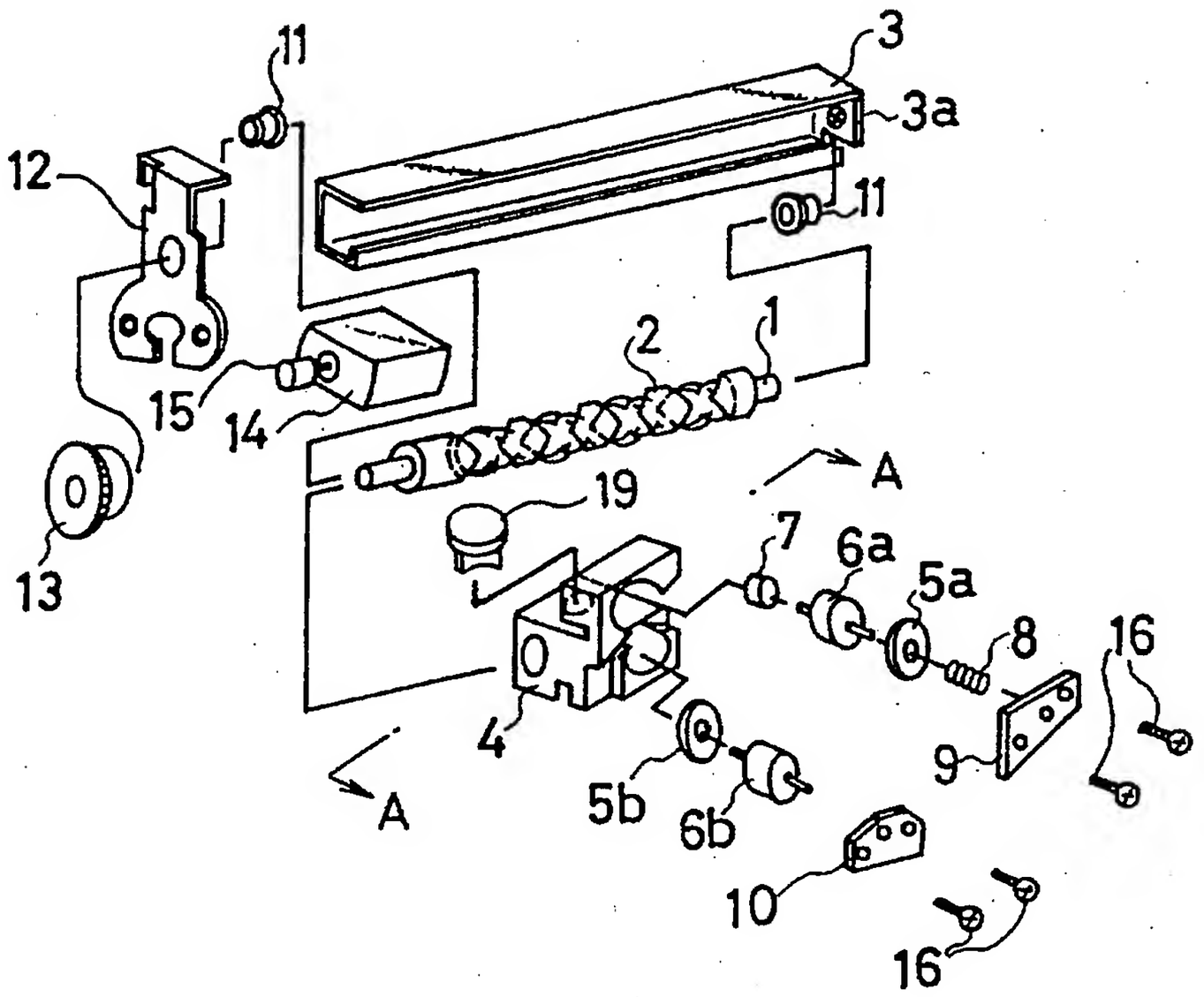


FIG. 2

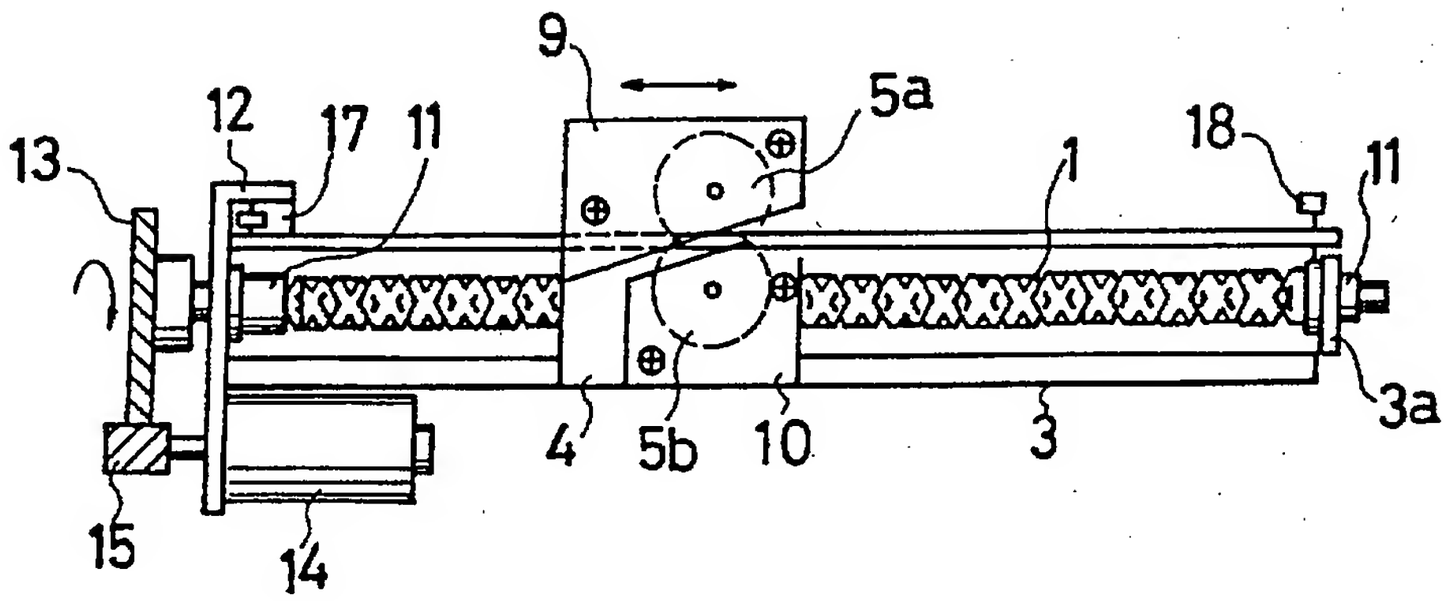


FIG. 3

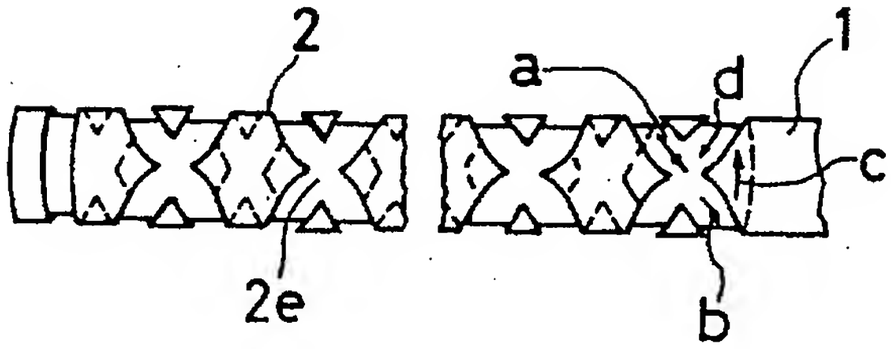


FIG. 4(a) FIG. 4(b) FIG. 4(c)

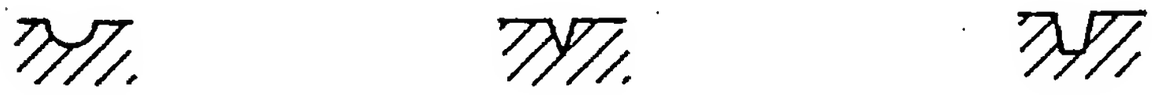


FIG. 4(d) FIG. 4(e) FIG. 4(f)

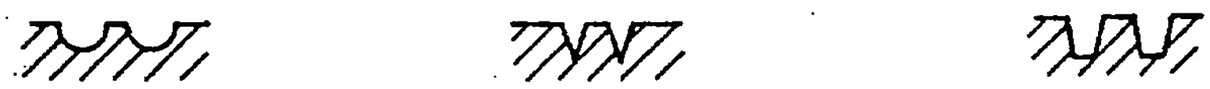


FIG. 5

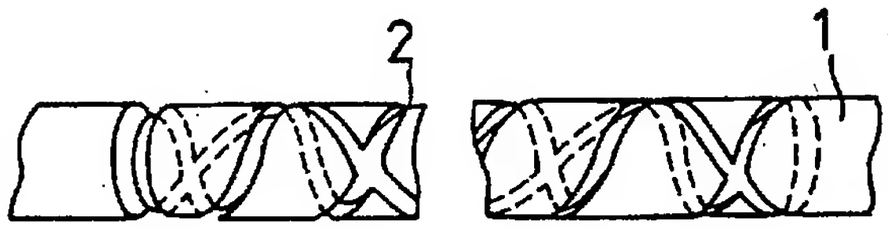


FIG. 6

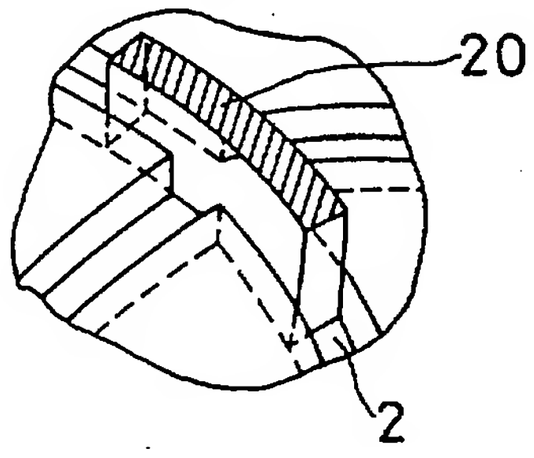


FIG. 7

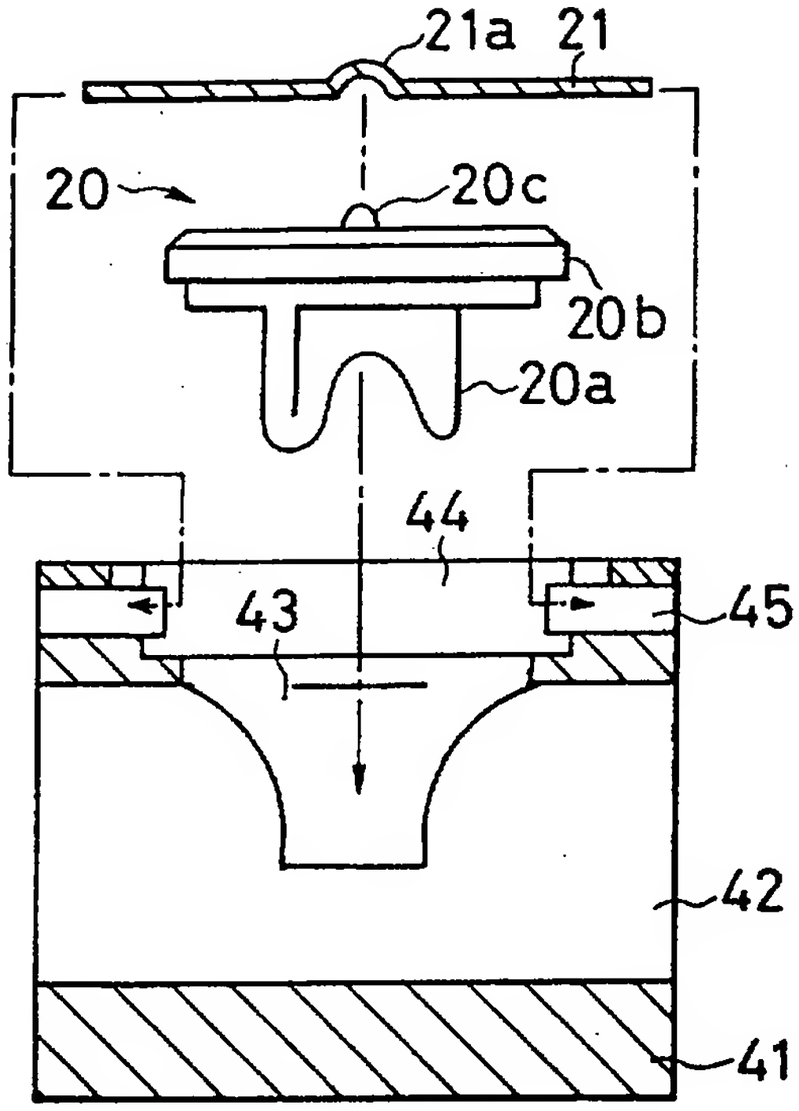

21a
21
20
20c
20b
20a
44
43
45
42
41

FIG. 8

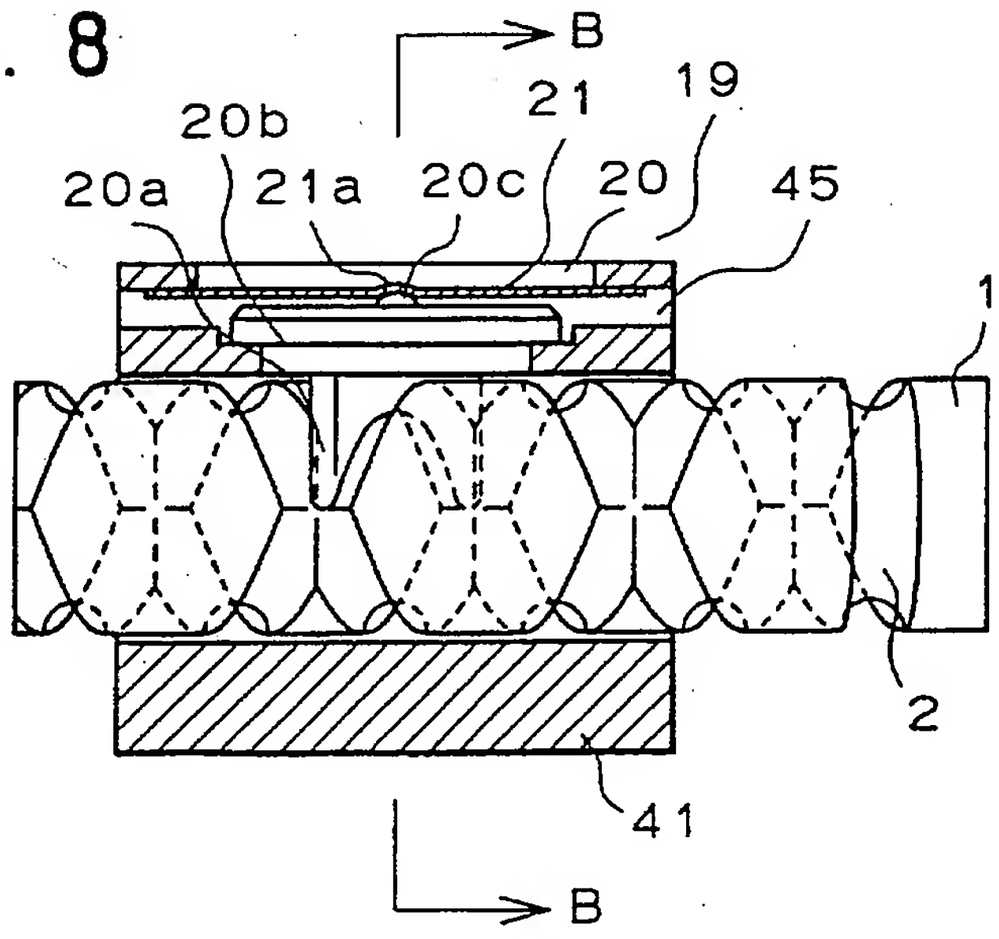
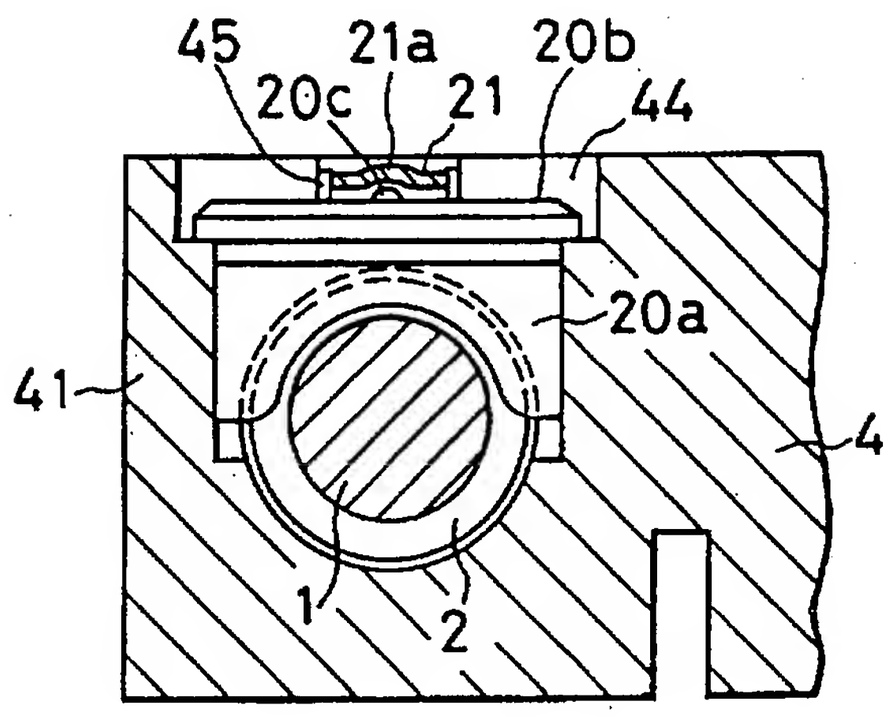

B
21
19
20b
20a
21a
20c
20
45
1
2
41
B

FIG. 9



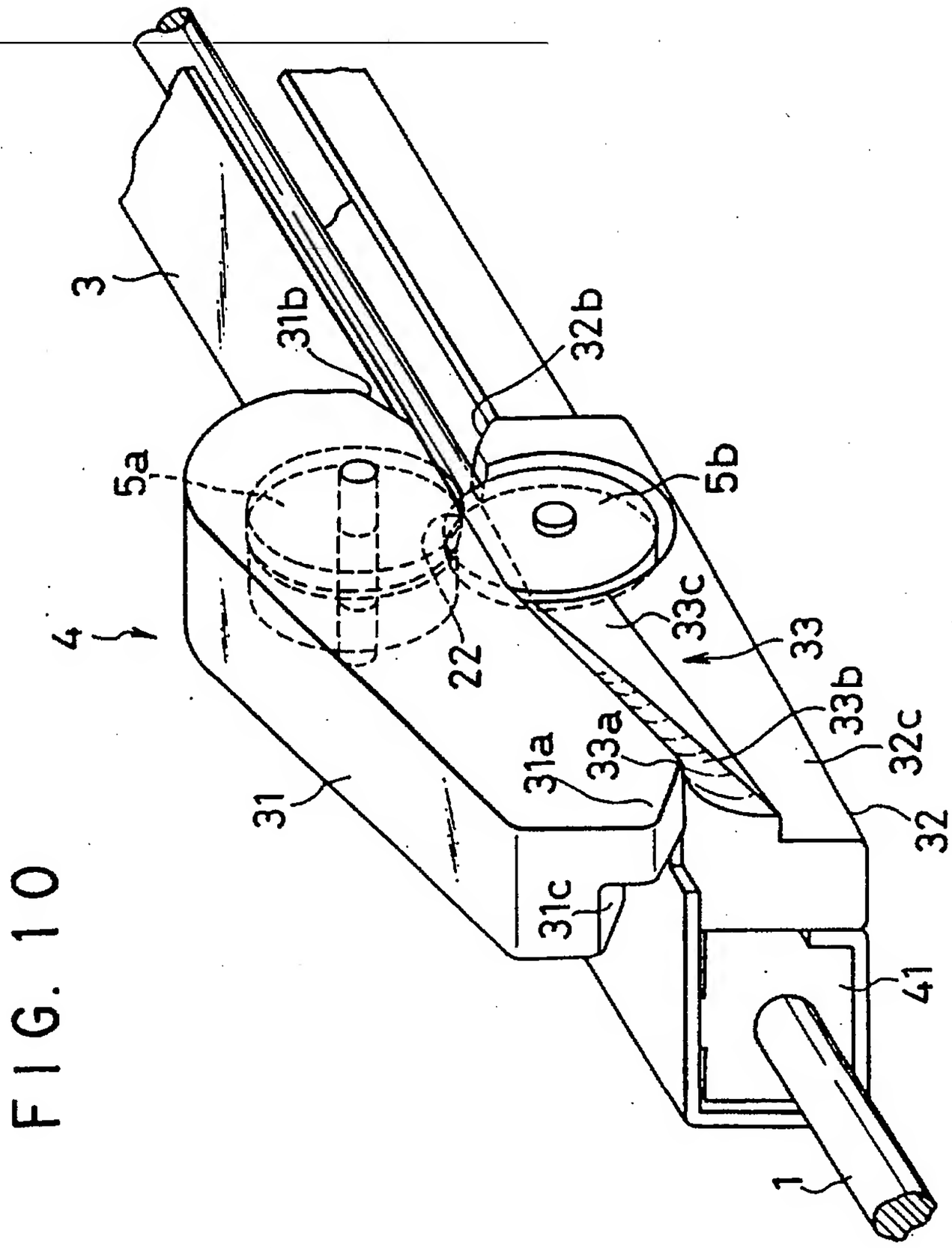


FIG. 10

FIG. 11

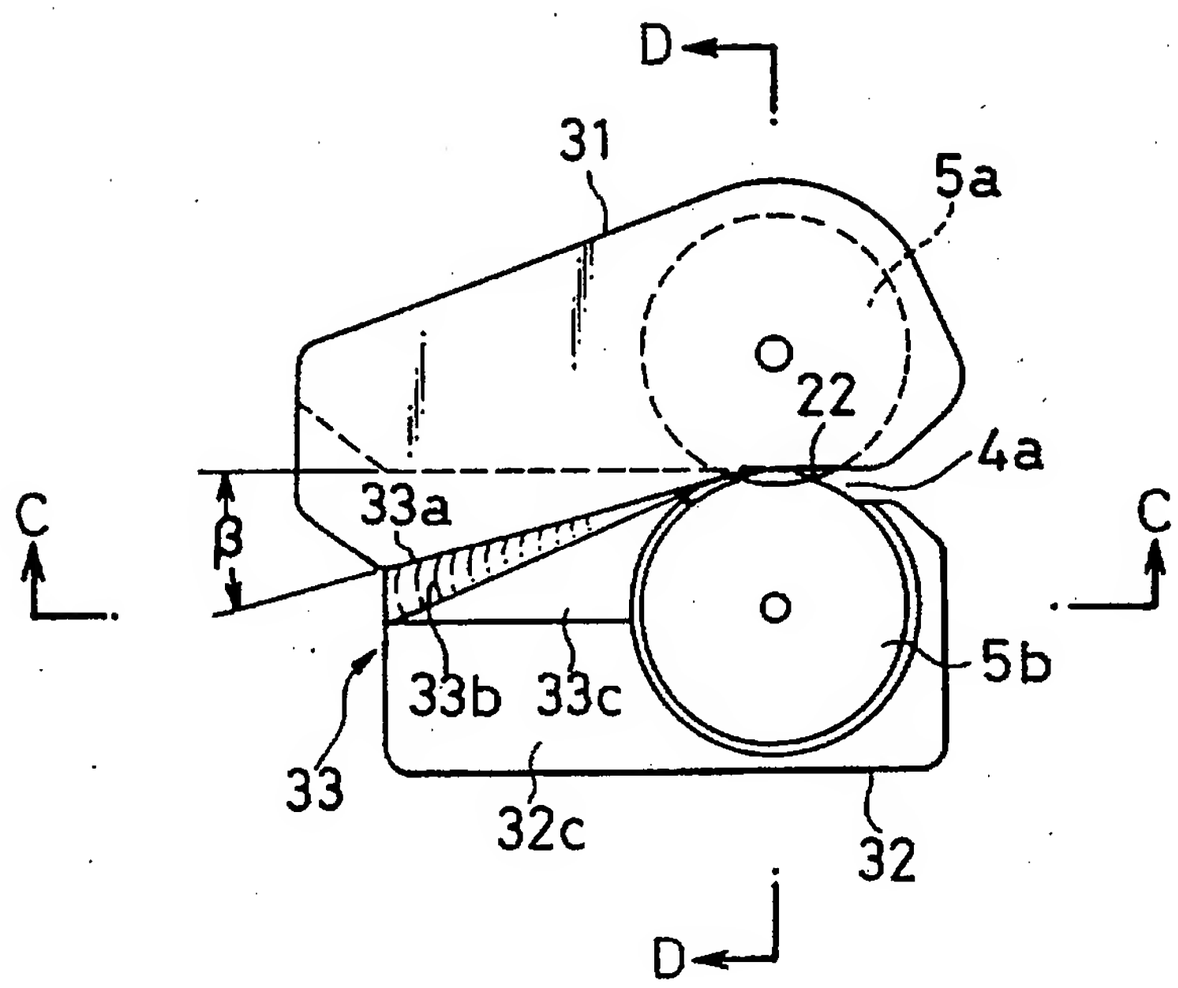


FIG. 12

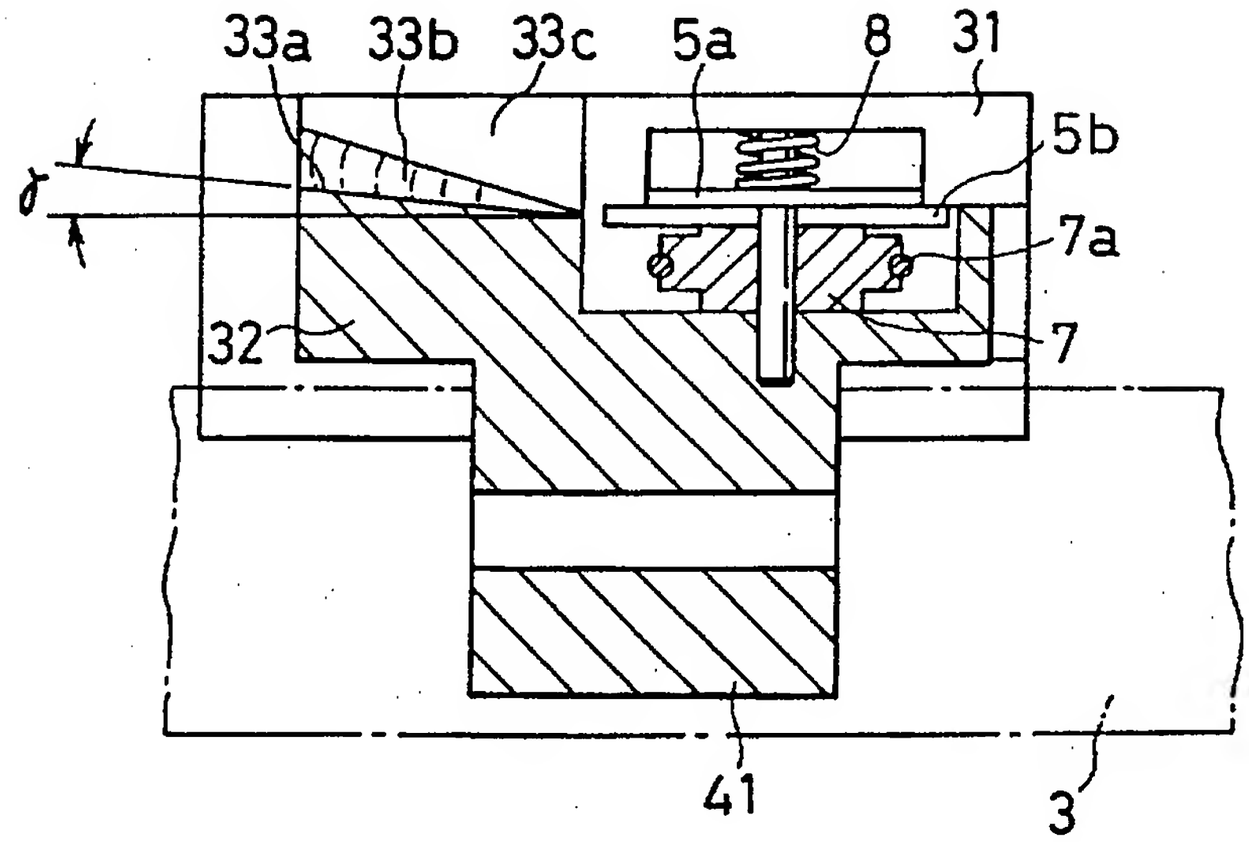

33a
33b
33c
5a
8
31
5b
7a
7
32
γ
41
3

FIG. 13

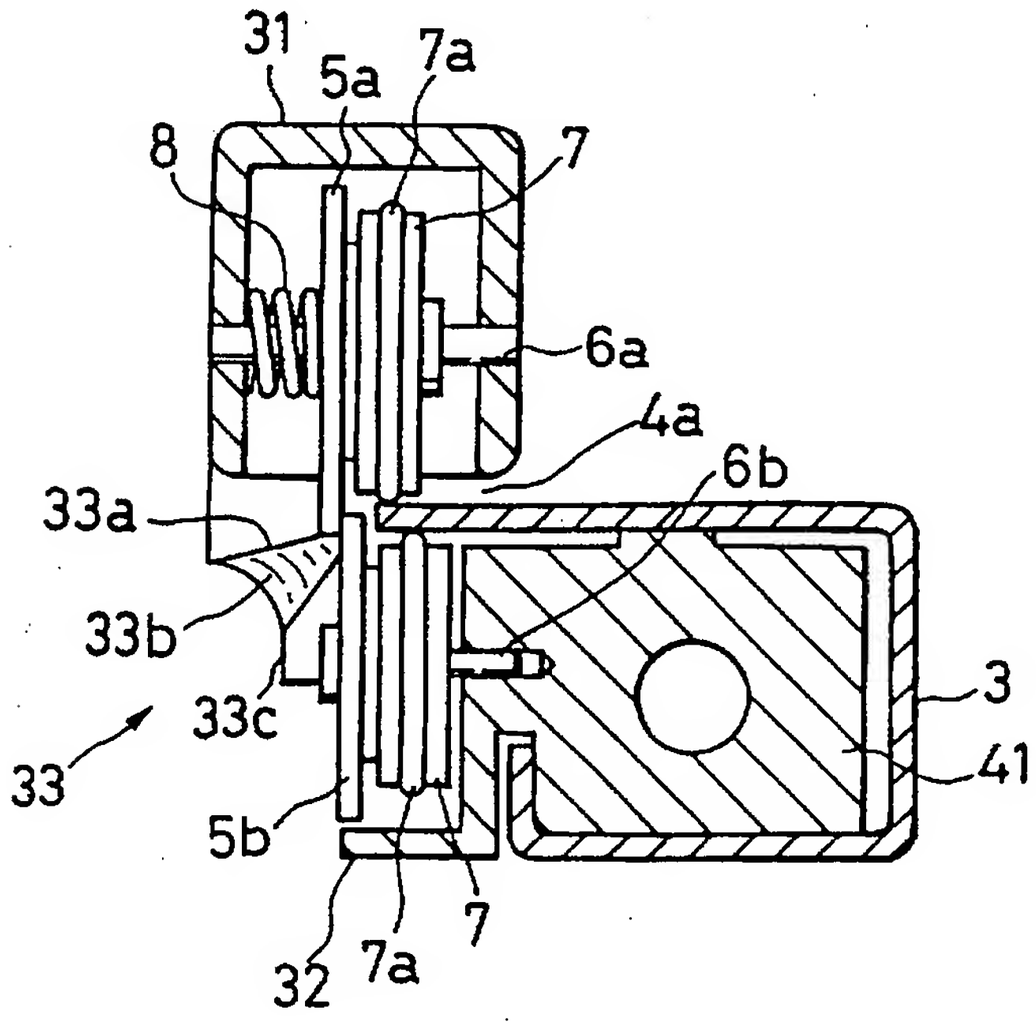

31
5a
7a
8
7
6a
4a
6b
33a
33b
33c
33
3
41
5b
7
32
7a

FIG. 14

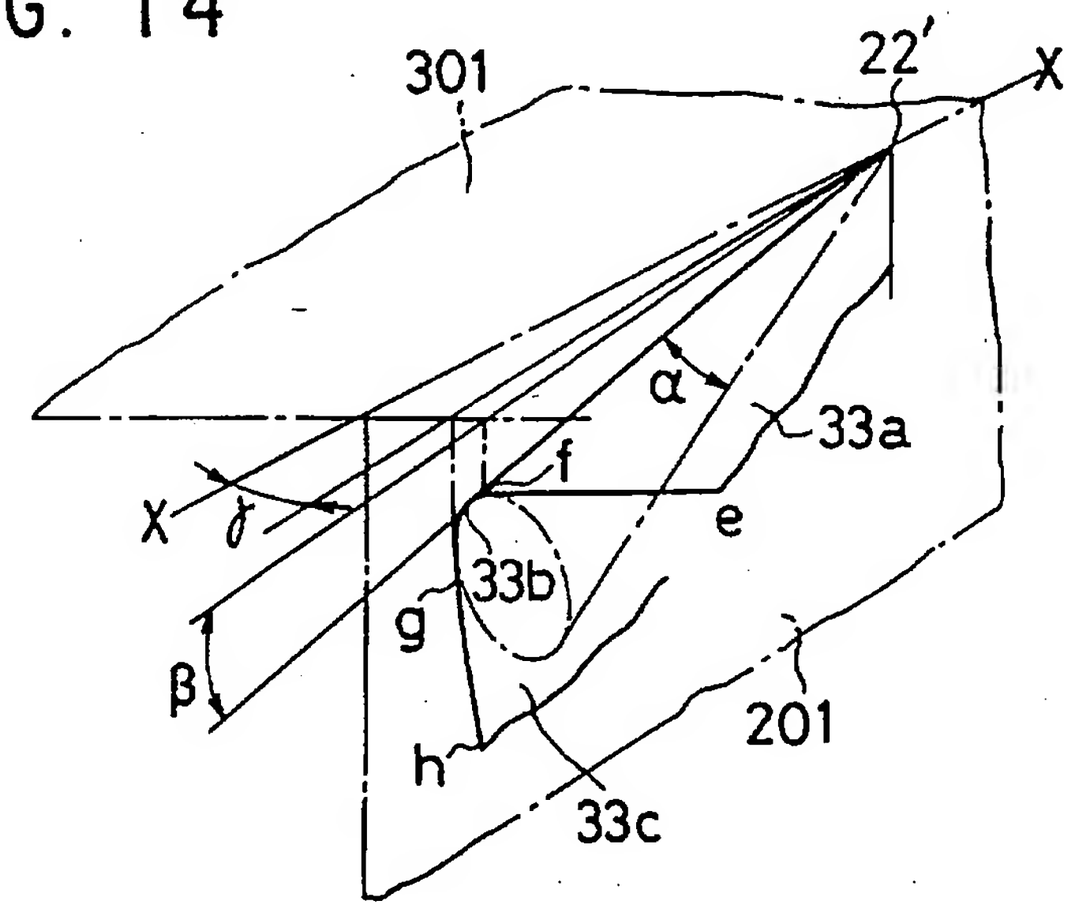


FIG. 15

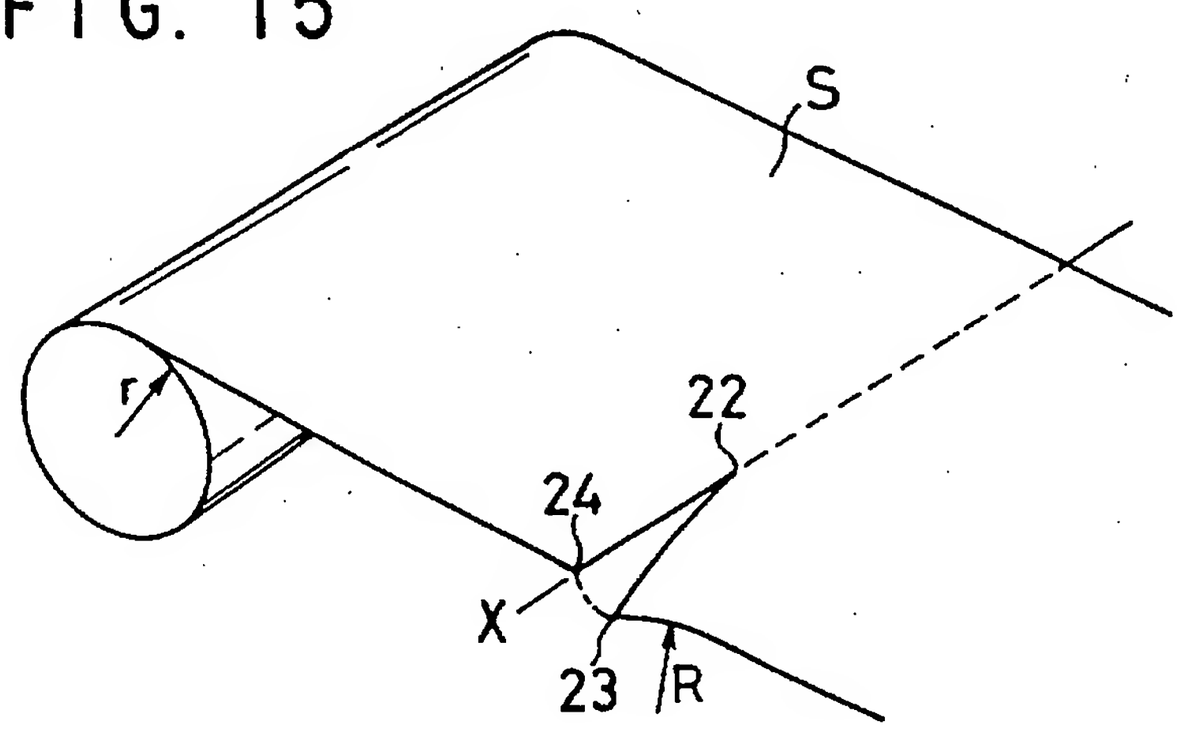
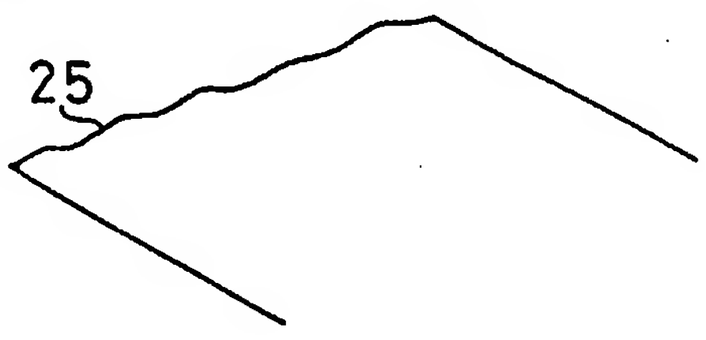


FIG. 16



SHEET CUTTER

The present invention relates to a sheet cutter for cutting a sheet material such as paper and the like, suitable for use in copying machines, printers, facsimiles and like office automation instruments. More particularly, the present invention relates to a sheet cutter which is provided with an improved drive unit of a knife carriage and is excellent in quietness and steadiness in a cutting operation of the sheet material.

Conventional sheet cutters incorporated in copying machines, printers, facsimiles and like office automation instruments are classed under two classes: a so-called rotary-type sheet cutter in which a swinging knife is brought into contact with a stationary knife to cross-cut the sheet material such as paper and the like; and, a so-called slide-type sheet cutter in which a vertically movable knife is brought into contact with a stationary knife to cross-cut the sheet material. However, in a cutting operation of the sheet material, any of the

conventional sheet cutters must drive its movable knife having a considerable length corresponding to a width of the sheet material being cross-cut, and, therefore requires a large power for driving such large knife, which makes it impossible to downsize the conventional sheet cutter.

In addition to the above conventional sheet cutters, there is another type of conventional sheet cutter, which is a so-called roller-type sheet cutter, for example such as one disclosed in Japanese Patent Laid-Open No. Hei 7-52085 in which a knife carriage provided with a circular knife travels to cross-cut the sheet material such as paper and the like. Such a carriage-traveling type of sheet cutters (i.e., roller-type sheet cutters) is smaller in driving power of the knife than any of the rotary-type and the slide-type sheet cutters, and is substantially free from restrictions on a width of the sheet material being cross-cut. Therefore, it is possible for the roller-type sheet cutter to cross-cut the sheet material of any width and to be downsized. More specifically, one of the roller-type sheet cutter, which is provided with a pair of circular knives in the knife carriage, does not require a large stationary knife, and is therefore advantageous in

cross-cutting the sheet material with a large width and also advantageous in being downsized.

In the conventional sheet cutter of such a carriage-traveling type (i.e., roller-type), there is employed a drive unit for reciprocating the knife carriage by pulling the carriage through a wire or a tooth belt, the drive unit also serving as a means for driving the knives of the sheet cutter. However, such a conventional drive unit has the disadvantage that the knife carriage hits its stopper means and like components due to its inertia to produce a noise of hitting each time the carriage changes direction at each of its stroke ends. In other words, the conventional drive unit is noisy in operation. Therefore, incorporation of such noisy drive unit into the office automation instruments, in which quietness in operation is required, is very disadvantageous.

Another conventional drive unit has been proposed, that is a screw-drive type in which the knife carriage is provided with a female screw threadably engaged with a male screw of a drive shaft. In operation, the drive shaft rotates in both directions alternately to reciprocate the knife carriage along the length of the drive shaft. The screw-drive type drive unit is

provided with a limit switch in each of opposite ends of an outgoing or a return stroke of a guide passage of the knife carriage. By means of such limit switches, a motor and like movers for rotatably driving the drive shaft is controlled so as to change the traveling direction of the carriage in its reciprocating motion.

Further, in the conventional roller-type sheet cutter, generally, a cut end of the sheet material such as paper and the like is not guided during a cutting operation of the sheet material. After completion of the cutting operation, the cut end of the sheet material is permitted to drop on a tray by gravity and stacked thereon. More particularly, in one of the roller-type sheet cutters provided with no guide means in its upper portion to permit the sheet material to be simply disposed on an upper surface of a frame of the sheet cutter in the cutting operation of the sheet material, since the drive unit is disposed under the frame, there is a risk that the cut-off end of the sheet material may interfere with the knife carriage in the reciprocating operation of the carriage and further interfere with the thus stacked cut ends of the sheet material. A solution to the above problem has been already found in a conventional

forced discharge means (for example such as that disclosed in Japanese Patent Laid-Open No. Hei 6-134692 or Hei 7-52085) for forcibly discharging the cut end of the sheet material onto a position spaced as apart as possible from a cutting position of the sheet material, in which cutting position a circular knife is brought into sliding-contact with a stationary knife or another circular knife to cut the sheet material.

By the way, as is clear from the above description, the conventional screw-type drive unit has the disadvantage that it requires the drive shaft reversing mechanism and the control circuit operated by the limit switches, and is therefore provided with a large number of components, which makes the drive unit complicated in construction, makes it impossible to downsize the unit and increases the manufacturing cost thereof. Further, in the office automation instruments, quietness in operation is one of the essential requirements for their cutters. To meet the above requrement of downsizing the inventors of the present invention try to use a sheet cutter which uses a drive shaft provided with an endless helical guide passage comprising an outgoing stroke and a return stroke. In such a sheet

cutter, the outgoing stroke is connected with the return stroke at its opposite ends and is opposite to the same in winding direction of the guide passage. In this operation, the drive shaft of the sheet cutter is rotated to move a knife carriage along the length of the drive shaft. However, since the outgoing stroke and the return stroke are opposite to each other in winding direction of the guide passage and separately formed on the drive shaft, a considerable noise is produced in operation of the sheet cutter, which makes it impossible to use the sheet cutter as an incorporated component of the office automation instruments such as facsimiles and the like requiring quietness in operation. Further, in the conventional roller-type sheet cutter, there is used a sheet-material discharge means in which the cut end of the sheet material is forcibly discharged to assume a wavy shape. This is another problem inherent in the conventional roller-type sheet cutter.

It is an object of the present invention, at least in its preferred embodiments, to solve the above problems by providing a sheet cutter for cross-cutting a sheet material such as paper and the like, which cutter has its knife carriage reciprocate in a width direction of the sheet material, is incorporated in office automation instruments, realizes a substantially noise-free and steady operation and eliminates the fear that a cut end of the sheet material assumes a wavy shape.

As the result of many years of research, the inventors of the present invention have found that a noise of metal scratching is produced when a drive shaft is rotated so that a guide member of the knife carriage passes through intersections (denoted by the reference character 2e in Fig. 3) of the outgoing stroke and the return stroke of the guide passage. The inventors of the present invention have found that such a scratching noise can be eliminated by using resin-molded components in the drive shaft and the like. According to this

finding, the present invention was made. Namely, in the sheet cutter of the present invention, both the helical guide passage and the engagement member of the knife carriage are resin-molded.

According to a first aspect of the present invention, there is provided:

a sheet cutter for cutting a sheet material by reciprocating a knife means in an outgoing stroke portion and a return stroke portion of a guide passage, comprising:

a drive shaft provided with the guide passage in its outer peripheral surface, the guide passage assuming a helical shape;

a knife carriage provided with an engagement member engaged with the helical guide passage;

the knife means being carried by the knife carriage;

a drive means for rotatably driving the drive shaft;

the guide passage being constructed with the outgoing stroke portion assuming a helical shape and the return stroke portion assuming a helical shape, the outgoing stroke portion being opposite to the return stroke portion in winding direction of the helical shape, the outgoing stroke portion having at least one of its opposite ends connected with a corresponding one end of the return stroke portion;

the guide passage of the drive shaft being resin-molded; and

the engagement member of the knife carriage being resin-molded and rotatably supported by the knife carriage.

In the sheet cutter of the present invention, the drive means rotatably drives the drive shaft which has its helical guide passage resin-molded. On the other hand, the engagement member, which is rotatably mounted on the knife carriage and engages with the helical guide

passage of the drive shaft, is also resin-molded. Consequently, the sheet cutter of the present invention may substantially eliminate a noise of metal scratching, which is hitherto produced when the metallic drive shaft engaged with the metallic engagement portion of the knife carriage of the conventional sheet cutter is driven to move the knife carriage. In the sheet cutter of the present invention, since the helical guide passage of the drive shaft is resin-molded, the sheet cutter of the present invention has the advantage that such guide passage is easily produced at a low cost and does not require any special lubrication.

When the helical guide passage is constructed of a helical groove assuming an outwardly flaring shape in cross section, it is possible to form a continuous guide groove at the bottom of intersections of the outgoing stroke portion and the return stroke portion of the guide passage, which makes it possible to smoothly guide the engagement member of the knife carriage along the guide passage of the drive shaft. This enhances quietness in operation of the sheet cutter of the present invention, and makes it possible to easily separate a mold from the resin-molded guide passage of the drive shaft in production, which considerably reduces the manufacturing cost of the sheet cutter of the present invention.

Preferably, the outgoing stroke portion and the return stroke portion of the guide passage of the drive shaft are connected with each other at opposite ends thereof so that the guide passage is formed into an endless type guide passage.

Due to the presence of such endless type guide passage, it is possible for the sheet cutter to have the knife carriage reciprocate in the outgoing stroke portion and the return stroke portion of the guide passage of the drive shaft without using any special reversing means for throwing the drive shaft into

reverse. More specifically since the outgoing stroke portion and the return stroke portion of the guide passage are connected with each other at at least one of or all of their opposite ends to form the endless type guide passage, the knife carriage may travel the outgoing stroke from its starting point to its end point when the drive shaft is rotated, the rotation of which is converted into a linear motion of the knife carriage along the length of the drive shaft. At the end point of the outgoing stroke portion of the guide passage, the knife carriage automatically changes direction without using any reversing means described above, because the knife carriage enters the return stroke portion of the guide passage of the drive shaft. Namely, at this time, the knife carriage smoothly enters the return stroke portion of the guide passage as if it were tracing a smooth line drawn with a single stroke of the brush.

Particularly, in the guide passage of the drive shaft in which the outgoing stroke portion of the guide passage is smoothly connected with the return stroke portion thereof at its opposite ends to from an endless-type helical guide passage, the knife carriage may automatically change direction without using any reversing means each time the knife carriage reaches its extreme leftward and rightward positions in the guide passage. Namely, in this case the knife carriage may automatically enter again the outgoing stroke portion of the guide passage when it reaches the end (ie., the extreme leftward position) of the return stroke portion of the guide passage which end equals the starting point of the outgoing stroke portion of the guide passage to enable the knife carriage to reciprocate the length of the drive shaft as long as the drive shaft rotates

Consequently, a unidirectional rotation of the drive shaft enables the knife carriage to reciprocate in the outgoing stroke portion and the return stroke portion of the guide passage of the drive shaft along

the length thereof. Further, by using the endless type guide passage, a noise of hitting the knife carriage onto a stopper means and the like produced at the end of the guide passage due to the inertia of the carriage may be eliminated, which makes it possible to realize a substantially noise-free sheet cutter without using any reversing means.

Preferably, the return stroke of the guide passage of the drive shaft is larger in pitch of the winding of the helical guide passage than the outgoing stroke portion of the guide passage.

Due to this construction, when no cutting operation of the sheet material is conducted in the return stroke portion of the guide passage to release the knife carriage from cutting loads of the sheet material, it is possible, without increasing the rotational speed of the drive shaft, for the knife carriage to reduce its return time which is required of the knife carriage to return to its rest position in the return stroke portion of the guide passage.

Preferably, the engagement member of the knife carriage is provided with a guide member which is brought into sliding-contact with the helical guide passage of the drive shaft and sits astride thereon to cover at least one third of a circumferential length of the drive shaft at its root portion or the bottom of the helical groove of the guide passage, the knife carriage being driven by the drive shaft through the sliding-contact between the guide member and the drive shaft.

In the helical guide passage of the drive shaft, since the outgoing stroke portion and the return stroke portion of the guide passage are opposite to each other in winding direction of the helical guide passage, the guide passage is provided with a plurality of intersections (denoted by the reference character 2e in Fig. 3) of the outgoing stroke portion and the return stroke portion of the guide passage. Consequently,

there is the risk that the engagement portion of the knife carriage moves in a direction perpendicular to the length of the guide passage to hit a corner of the intersection so that a noise of hitting is produced each time the knife carriage carrying the knife means passes through the intersections of the guide passage of the drive shaft. In addition, there is also another risk that the engagement portion of the knife carriage drops out of the normal guide passage when the knife carriage is subjected to a heavy load.

The above problems are solved by providing the guide member in the engagement portion of the knife carriage so that the engagement portion's motion in the direction perpendicular to the length of the guide passage is reduced, whereby the noise of hitting is eliminated and the engagement member is prevented from dropping out of the guide passage of the drive shaft.

Incidentally, when the guide member of the knife carriage is brought into sliding-contact with the drive shaft to cover more than a half of the circumferential length of the drive shaft at its root portion or the bottom of the helical groove of the guide passage, it is difficult for the guide member to change direction at the end of the outgoing stroke portion or of the return stroke portion of the guide passage of the drive shaft in the cutting operation of the sheet material. Consequently, it is preferable that the guide member covers the bottom of the helical groove of the guide passage of the drive shaft by the amount of length equal to or less than a half of the circumferential length of the drive shaft at the bottom of the helical groove of the guide passage, provided that the amount of length is equal to or more than one third of the circumferential length of the drive shaft at the bottom of the helical groove of the guide passage, which enables the knife carriage to be smoothly reciprocated and not to produce any noise in the cutting operation of the sheet

material.

Preferably, the engagement member of the knife carriage comprises:

the guide member which assumes a forked shape and is provided with a handle portion rotatably supported by the knife carriage, and a forked portion brought into sliding-contact with the helical guide passage; and

an urging means for urging the guide member of the knife carriage into said helical guide passage.

The sheet cutter having the above construction may prevent the engagement member of the knife carriage from dropping out of the outgoing and the return stroke portions of the helical guide passage at their intersections, without fail. In addition, since the guide member has its forked portion engaged with the guide passage and is provided with a handle portion which is rotatably mounted in the knife carriage, the guide member is rotated on the axis of the handle portion to smoothly trace the guide passage of the drive shaft even when the knife carriage changes direction at each of the opposite ends of the outgoing and the return stroke portions of the guide passage of the drive shaft. In addition, since the guide member of the knife carriage is urged onto the bottom of the guide passage by means of an urging means while the guide member traces the helical guide passage, it is possible for the guide member of the knife carriage to smoothly trace the guide passage, which ensures that the guide member is prevented from dropping out of the guide passage and that any noise is prevented from being produced in operation.

Preferably, the drive means for rotatably driving the drive shaft comprises a motor and helical gears which transmit torque generated in the motor to the drive shaft.

With such a construction, a smooth meshing of the gears is accomplished. In addition, since the helical

gears are used in place of the spur gears, gear noises are considerably reduced in operation. In view of axial thrust and quietness in operation, it is preferable for each of the helical gears to have a helix angle of from 10 to 30 degrees.

Preferably, the drive shaft is mounted inside a hollow elongated member serving as a guide rail which extends along the drive shaft; and

the knife carriage is provided with a sliding portion which is brought into sliding-contact with an inner surface of the hollow elongated member.

In a sheet cutter having the above construction, since the drive shaft is disposed inside the hollow elongated member, any rotating components are not exposed to the user, which improves the sheet cutter of the present invention in safety and enables the sheet cutter to be downsized. Since the sliding portion of the knife carriage is designed so as to be brought into sliding-contact with the inner surface of the hollow elongated member, it is possible to dispose the sheet material on an upper surface of the hollow elongated member in its cutting operation.

Preferably the sheet cutter further comprises a forced discharge portion provided in a back side of knife carriage; and

the forced discharge portion comprises a first guide surface for urging downward a cut end of the sheet material so that the cut end becomes lower in level than a cutting position of the sheet material, a second guide surface assuming a substantially conical surface of a circular cone having its vertex disposed in a position near the cutting position so that the cut end of the sheet material is permitted to curl and guided to its discharge area, and a third guide surface for permitting the cut end of the sheet material thus kept in curl to escape to the downstream side of feeding direction of the sheet material.

Though the above construction of the sheet cutter of the present invention is not applied only to a specific sheet material being cut, it is preferably applied to a sheet material kept in curl so as to permit the cut end of the sheet material to curl downward in the cutting operation of the sheet material. For example, in case of a roll of thermosensitive recording sheet material which is used in facsimiles and the like and kept in curl, in the cutting operation of the sheet material: a cut end of the sheet material is first guided by the first guide surface of the forced discharge portion of the sheet cutter so as to be urged or directed downward while it begins to curl due to its initial rolled shape; then, guided further downward by the second guide surface so as to move along the conical surface of the second guide surface; and, finally guided by the third guide surface so as to escape to the downstream side of flow of the sheet material. Consequently, the cut end of the sheet material can be smoothly separated from its cutting position, which prevents the cut end of the sheet material from being formed into a wavy shape, ensures a steady cutting operation of the sheet material and further prevents an intermittent noise due to such wavy shape of the cut end from being produced.

Preferably, the first guide surface of the forced discharge portion comprises a plane which extends from the position near the cutting position of the sheet material to form a downward angle of from 5 to 20 degrees with a sheet-contact surface of the elongated member;

the second guide surface of the forced discharge portion is comprises a substantially conical surface of a circular cone with the vertical angle of from 10 to 40 degrees, the cone having its base disposed in the downstream side of feeding direction of the sheet material and the vertex disposed in the position near

the cutting position of the sheet material;

and the third guide surface of the forced discharge portion comprises a plane which extends from the position near the cutting position of the sheet material toward the downstream side of flow of the sheet material to form an angle of from 5 to 15 degrees with a vertical plane passing through a cutting line of the sheet material;

the first, second and the third guide surfaces of the forced discharge portion of the sheet cutter being smoothly connected with each other to form a guide surface for guiding the cut end of the sheet material to the downstream side of flow of the sheet material.

The conical surface described above is not strictly defined mathematically and may assume any shapes resembling a conical shape in practice. Incidentally, the number of the above-mentioned guide surfaces of the forced discharge portion of the sheet cutter of the present invention is three which is a possible minimum number in the sheet cutter, and therefore may be increased if necessary in applications.

The knife means may comprise a movable circular knife rotatably mounted on the knife carriage and a substantially straight stationary knife;

the movable circular knife being brought into sliding-contact with the stationary knife to cut the sheet material.

Alternatively, the knife means may comprise a first circular knife and a second circular knife both of which are rotatably mounted on the knife carriage; the first circular knife being brought into sliding-contact with the second circular knife to cut the sheet material.

The sheet cutter may further comprise a rotating means which rotatably drives at least one of the first and the second circular knife to have it bite into the sheet material when the knife carriage travels.

Other objects, features and advantages of at least

the preferred forms of the present invention will be readily apparent to those skilled in the art from a reading of the following brief description of the drawings, the detailed description of the preferred embodiments, and the appended claims, as well as the prior art that is herein incorporated by reference.

Preferred embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:-

Fig. 1 is an exploded perspective view of the sheet cutter of an embodiment of the present invention;

Fig. 2 is a front view of the sheet cutter;

Fig. 3 is a front view of an essential part of an endless-type guide passage formed in a shaft of the sheet cutter;

Figs. 4(a), 4(b), 4(c), 4(d), 4(e) and 4(f) are cross-sectional views of grooves of the guide passage formed in the shaft of the sheet cutter;

Fig. 5 is a perspective view of another embodiment of the guide passage formed in the shaft, in which an outgoing part of the guide passage is larger in pitch than a return part of the guide passage;

Fig. 6 is an enlarged perspective view of an embodiment of a connecting member of the sheet cutter;

Fig. 7 is an exploded cross-sectional view of a guide member of the sheet cutter, taken along the line A-A of Fig. 1;

Fig. 8 is a cross-sectional view of the guide member of the sheet cutter after assembly of the guide member, taken along the line A-A of Fig. 1;

Fig. 9 is a cross-sectional view of the guide member, taken along the line B-B of Fig. 8 (i.e., substantially taken along the helical guide passage of the sheet cutter);

Fig. 10 is a perspective view of a carriage with a forced discharge portion of the sheet cutter, illustrating the details of the carriage;

Fig. 11 is a front view of the carriage with the forced discharge portion;

Fig. 12 is a cross-sectional view of the carriage, taken along the line C-C of Fig. 1;

Fig. 13 is a cross-sectional view of the carriage, taken along the line D-D of Fig. 11;

Fig. 14 is a view illustrating curvature of a guide surface of the forced discharge portion of the carriage of the sheet cutter;

Fig. 15 is a view illustrating a cutting operation of 1 sheet material supplied from a roll of the sheet material; and

Fig. 16 is a view illustrating a wavy condition of a cut end portion of the sheet material.

Hereinbelow, preferred embodiments of a low noise sheet cutter of the present invention will be described in detail with reference to the accompanying drawings.

As shown in the drawings, particularly in Fig. 1, fixedly mounted on a carriage through a plurality of fastening screws 16 are a first bearing 9 for rotatably supporting a first axle 6a of a first circular knife 5b; and, a second bearing 10 for rotatably supporting a second axle 6b of a second circular knife 5b. The first axle 6a has its opposite ends rotatably supported by the first bearing 9 and another bearing mounted in the carriage 4. In substantially the same manner, the second axle 6b has its opposite ends rotatably supported by the second bearing 10 and further another bearing mounted in the carriage 4. The first circular knife 5a is fixedly mounted on the first axle 6a in a manner such that the first circular knife 5a has its cutting edge adjacent to that of the second knife 5b which is

fixedly mounted on the second axle 6b. In addition, under such circumstances, the first circular knife 5a has its cutting edge brought into press-contact with that of the second circular knife 5b under the influence of a resilient force exerted by a compression coil spring 8. On the other hand, a resilient roller 7, which is fixedly mounted on the first axle 6a, is brought into frictional-contact with an upper inner surface of a hollow elongated member 3 and rotatably driven by the member 3 when the carriage 4 moves along the length of the elongated member 3, so that torque for rotatably driving the first circular knife 5a is produced in the roller 7 and transmitted to the knife 5a.

In another embodiment of the resilient roller 7 of the present invention, as shown in Fig. 13, the resilient roller 7 has a resilient O-ring 7a fixedly mounted on its outer peripheral surface, and is then fixedly mounted on each of the first and the second circular knives 5a, 5b. When the carriage 4 moves along the length of the elongated member 3, since the resilient O-ring 7a of the roller 7 of each of the first and the second knives 5a, 5b is brought into frictional-contact with the surface of the elongated member 3, both the resilient rollers 7 shown in Fig.

13 are rotatably driven so that the first and the second circular knives 5a, 5b are also rotatably driven to have their cutting edges bite into the sheet material. The carriage 4 has a construction in which a sliding portion 41 of the carriage 4 is slidably mounted in the hollow elongated member 3. This member 3 serves as a guide rail having a substantially C-shaped cross section, in which the carriage 4 slidably reciprocates along the length of the elongated member 3. Formed in the sliding portion 41 of the carriage 4 is an axial through-hole 42 which extends in the axial direction of a drive shaft 1 to slidably receive the drive shaft 1 therein.

Further, as shown in Fig. 2, a rest-position detection switch 17 is fixedly mounted on a side plate 12 to detect a time when the carriage 4 returns to its left-hand rest position as viewed in Fig. 2.

The drive shaft 1 is received in the hollow elongated member 3, and has its opposite ends rotatably supported by an end plate 3a of the elongated member 3 and a side plate 12 through a pair of bearings 11. A resin-molded guide passage 2 is formed in an outer peripheral surface of the drive shaft 1 and constructed with a helical groove (hereinafter referred to as the guide passage). The

guide passage 2 is integrally formed with the drive shaft 1, or separately molded from a resin onto the outer peripheral surface of the drive shaft 1. Due to such resin-molded guide passage 2 and a connecting member 20 (described later) of resin-molded type, it is possible for the sheet cutter

to provide a substantially noise-free drive mechanism. As shown in Fig. 3, of the guide passage 2 on the drive shaft 1, an outgoing stroke helically extends in a direction opposite to the winding direction of a return stroke helically wound on the drive shaft 1, and is smoothly connected with the return stroke at each of a start point and a terminal point of the outgoing stroke or of the return stroke, so that the guide passage 2 of endless type is formed in the drive shaft 1. As shown in Figs. 4(a), 4(b), 4(c), 4(d), 4(e) and 4(f), the helical groove or guide passage 2 is configured in cross section to flare outwardly so as to facilitate removal of a mold in a molding operation of the guide passage 2. Therefore, it is possible for the guide passage 2 to assume in cross section any of: (a) substantially semicircular shapes; (b) substantially V shapes; and, (c) substantially U shapes.

Of the guide passage 2, the outgoing stroke

may be equal in pitch of winding to the return stroke. Further, as shown in Fig. 5, when the return stroke is larger in pitch of winding than the outgoing stroke and no cutting of the sheet material is conducted in the return stroke, it is possible to reduce a return time of the carriage 4 in the return stroke in which the carriage 4 is free from a cutting load of the sheet material. As shown in Figs. 4(d), 4(e) and 4(f), the guide passage 2 may be constructed of double-thread type grooves or multiple-thread type grooves. In this case, the carriage 4 may be provided with at least a pair of engagement portions through which the carriage 4 engages with these grooves of the guide passage 2, which reduces the wear occurring with the grooves of the guide passage 2. Incidentally, though the guide passage 2 is constructed of at least one helical groove in this embodiment of the present invention, the guide passage 2 may be constructed of at least one helical ridge or thread instead of the groove in another embodiment of the present invention. When the guide passage 2 is constructed of such helical ridge or thread, it is necessary to prevent interference between the engagement portions of the carriage 4 and the helical ridge or thread of the guide passage 2 by providing gaps in each of

intersections of the outgoing stroke and the return stroke of the guide passage 2, for example, as is in the scissors crossing of railways.

A sliding portion 41 of the carriage 4 is slidably moved along an inner surface of the elongated member or guide rail 3, and provided with an engagement member 19 which is engaged with the guide passage 2 of the drive shaft 1. As shown in Fig. 6, in the engagement member 19 of the carriage 4, a guide member 20 is slidably mounted in the guide passage 2, and has a sliding contact surface the length of which is longer than a width of the helical groove of the guide passage 2. In order to prevent the guide member 20 from dropping out of the intersections of the outgoing stroke and the return stroke of the guide passage 2, it is preferable that the length of the guide member 20 is equal to or longer than one third of a circumferential length of the drive shaft 1 provided with the helical groove. In the embodiment of the present invention, the engagement member 19 of the carriage 4 has the following construction to ensure preciseness in operation.

Now, the engagement member 19 of the carriage 4 in the embodiment of the present invention will be described in detail.

As is clear from Figs. 7 to 9, the engagement member 19 is constructed of the guide member 20 and a leaf spring 21 for urging the guide member 20. As shown in Figs. 7 and 8, the guide member 20 is provided with a forked, i.e., two-forked portion 20a and a handle portion 20b serving as a handle of the two-forked portion 20a. The forked portion 20a of the guide member 20 has its forked ends reach halfway down in circumference the drive shaft 1 (as viewed in Fig. 8) to assume a concave shape which corresponds to the helical groove of the guide passage 2 and engages therewith. The guide member 20 is mounted in a radial hole 43 which is formed in the carriage 4 so as to intersect with the axial hole 42 at right angles. At this time, the handle portion 20b of the guide member 20 has its lower surface brought into contact with an enlarged-diameter portion 44 of the radial hole 43 so that the guide member 20 is rotatably supported in the radial hole 43 of the carriage 4. The concave-shaped portion of the forked portion 20a of the guide member 20 sits astride the bottom of the helical groove of the guide passage 2 of the drive shaft 1 which is slidably mounted in the axial hole 42 of the carriage 4. Since the guide member 20 is resin-molded, as is already described above, it is possible to realize a

substantially noise-less drive mechanism of the sheet cutter.

The leaf spring 21 assumes a rectangular shape, and has its opposite ends inserted in slits 45 of the carriage 4. In the carriage 4, the slits 45 intersects with the enlarged-diameter portion 44 of the radial hole 43 at right angles. In operation, a central portion of the leaf spring 21 urges a head of the handle portion 20b of the guide member 20 downward so that the guide member 20 is resiliently pressed against the guide passage 2 of the drive shaft 1, which prevents the engagement portion of the carriage 4 from dropping out of the guide passage 2 of the drive shaft 1 when the carriage 4 moves along the drive shaft 1. Provided in the central portion of the leaf spring 21 is a concave portion 21a which slightly urges downward a projection 20c formed in a central area of the handle portion 20b of the guide member 20, to permit the guide member 20 to rotate on its axis. Therefore, it is possible to prevent both the leaf spring 21 and the engagement portion of the carriage 4 from being dropped out of the guide passage 2 of the drive shaft 1. In a sheet cutter having the above construction, when the drive shaft 1 rotates, the forked portion 20a of the

guide member 20 is slidably moved along the helical groove of the guide passage 2 of the drive shaft 1. When the forked portion 20a of the guide member 20 reaches an end of the outgoing stroke of the guide passage 2, the forked portion 20a of the guide member 20 enters the return stroke of the guide passage 2 so that the carriage 4 smoothly transfers from the outgoing stroke of the guide passage 2 to the return stroke of the same as the drive shaft 1 rotates. Since the guide member 20 has a semicircular concave portion of its forked portion 20a sits astride the guide passage 2, is resiliently urged against the guide passage 2 by the leaf spring 21 so as to be permitted to rotate on its axis, there is no risk that the guide member 20 will drop out of the intersections of the outgoing stroke and the return stroke of the guide passage 2 and will be noisy.

A gear 13 in Fig 2 is fixedly mounted on an end portion of the drive shaft 1 in a position adjacent to the side plate 12 and meshes with a pinion gear 15 of a motor 14 to form a drive means through which the motor 1 transfers its torque to the drive shaft 1. In the embodiment of the present invention, each of the gear 13 and the pinion gear 15 is a resin-molded helical gear with a helix angle of 15 degrees. In this

connection, in order to reduce noise and axial thrust of the gears, the helix angle of each of the gears 13, 15 is preferably within a range of from 10 to 30 degrees. Since the helical gears are lower in noise level than spur gears, it is possible for both the resin-molded drive shaft 1 and the resin-molded engagement member 19 to reduce noise and realize a substantially noise-free sheet cutter.

The operation of the sheet cutter will be now described with reference to the drawings.

In Fig 2 when the motor 14 is actuated in a condition in which the carriage 4 is in its extreme leftward rest position, torque generated in the motor 14 is transmitted to the drive shaft 1 through the pinion gear 15 and the gear 13 to rotatably drive the shaft 1, so that the forked portion 20a of the guide member 20 engaging with the guide passage 2 of the drive shaft 1 is axially moved along the drive shaft 1. As a result, the guide member 20 is slidably moved along the guide passage 2 to have the carriage 4 move along the length of the drove shaft 1 in the outgoing stroke of the guide passage 2. At this time, the first circular knife 5 is rotatably driven by the resilient

roller 7 so as to bite into the sheet material being cut, and moved along the length of the drive shaft 1 in the outgoing stroke of the guide passage 2, whereby the sheet material (not shown) disposed on the upper surface of the elongated member 3 is cut between the first circular knife 5a thus rotated and the second circular knife 5b.

When the carriage 4 reaches its extreme rightward position in Fig 2 i. e. the end of the outgoing stroke of the guide passage 2 the cutting operation of the sheet material is completed After completion of the cutting operation of the sheet material, the drive shaft 1 is further rotatably driven, the guide member 20 follows the guide passage 2 to enter its return stroke. More specifically, as shown in Fig 3 the guide member 20 moves in a direction of the arrow " a" in the outgoing stroke of the guide passage 2 and follows in motion the solid--line arrow b and then the dotted-line arrow c at the end of the outgoing stroke, and finally enters the return stroke of the guide passage 2 as indicated by solid-line arrow d As a result, the guide member 20 is now driven along the return stroke of the guide passage 2 to have the carriage 4 move leftward along the length of the drive shaft 1 in the return stroke of the guide passage 2

When the carriage 4 reaches the end of the return stroke of the guide passage 2, substantially the same operation as occurred in the end of the outgoing stroke of the guide passage 2 occurs. In other words, the carriage 4 is transferred from the return stroke of the guide passage 2 to the outgoing stroke of the same at the end of the return stroke. Since the guide member 20 has its handle portion 20b rotatably supported by the sliding portion 41 of the carriage 4 to permit its forked portion 20a to be rotatable on its axis according to the helical groove of the guide passage 2, it is possible for the guide member 20 to smoothly follow the helical groove of the guide passage 2. When the carriage 4 reaches its extreme leftward rest position as viewed in Fig. 2 in the return stroke of the guide passage 2, a rest-position detection switch 17 for detecting the rest position of the carriage 4 is actuated to stop the motor 1 so that the carriage 4 stops at the rest position, whereby the cutting operation of the sheet material is completed. In this cutting operation of the sheet cutter of the present invention, noise is considerably reduced by employing the resin-molded parts such as the drive shaft 1 and the like in comparison with the conventional sheet cutters. The results of a noise-

level measuring tests of a sheet cutter according to the present invention are as follows:

(Noise-level measuring test results):

(Test conditions):

Dimensions of the drive shaft 1:

shaft diameter Φ= 6 mm; and

pitch of the helical groove = 7 mm

Angular velocity of the drive shaft 1:

5000 rpm

Materials of the drive shaft 1 and the engagement member 19:

polyacetal in the present invention; and

aluminum (machined) in a comparative example

Drive system:

spur gear type; and

helical gear type

Method for measuring noise:

according to JIS Z 8731, noise was measured by means of a noise meter at a position spaced apart from the sheet cutter by a distance of 1 meter.

Noise level:

the comparative example (the aluminum drive shaft and the spur gears) = 67 dB;

the present invention (the polyacetal resin-molded drive shaft and the spur gears) = 61 dB; and

the present invention (the polyacetal resin-molded drive shaft and the helical gears) = 58 dB

As is clear from the above test results, the resin-molded drive shaft 1 of the present invention was lower in noise level than the metallic drive shaft of the comparative example by the amount of 6 dB. When the spur gears were replaced with the helical gears, noise level became much lower than that of the comparative example by the amount of 9 dB.

As described above, by continuously driving the drive shaft 1 in one direction, it is possible to have the cutting knives 5a, 5b start cutting operation of the sheet material at their rest positions, travel both the outgoing stroke and the return stroke of the guide passage 2 and return to their rest positions. Consequently, there is no need for both a control circuit for reversing the rotation of the drive shaft 1 and limit switches disposed in opposite ends of the drive shaft 1 for realizing a reciprocating motion of the carriage 4 along the drive shaft 1, which simplifies in construction the sheet cutter and reduces the manufacturing cost

thereof.

Since the helical groove of the guide passage 2 of the drive shaft 1 is of an endless type and continuously rotated and reversed the rotation thereof in operation, there is no fear that the knife carriage 4 hits the end of the outgoing stroke or of the return stroke of the guide passage 2 to produce noise. Consequently, the sheet cutter

is a substantially noise-free unit. In addition, even when the motor 14 is thrown into reverse by mistake in polarity of the motor 14, the carriage 4 may travel both the outgoing stroke and the return stroke of the guide passage 2 and there is no fear that the motor 14 is damaged by burning.

As for the guide passage 2, when its return stroke is larger in pitch of winding of the helical groove than the outgoing stroke of the passage 2 and no cutting operation is conducted in the return stroke, it is possible to reduce a return time of the carriage 4 for returning to its rest position through the return stroke which is free from a cutting load of the sheet material. Further, when the guide passage 2 is constructed of a plurality of grooves of double-thread or multiple-thread screw type and the knife carriage 4 is provided with a plurality of engagement

portions engaging with these corresponding grooves of the guide passage 2, it is possible to minimize wear on guide surfaces of the grooves of the passage 2. Further, in case that each of the helical guide passage 2 of the drive shaft 1 and the engagement member 19 is resin-molded and the gears 13, 15 employed in the drive system of the sheet cutter are helical gears, the noise level of the sheet cutter of the present invention can be reduced by the amount of at least 10 percent in comparison with the conventional sheet cutter. Still further, since the helical guide passage 2 of the drive shaft 1 is resin-molded, it is possible to produce the guide passage 2 on a large-scale basis at a low cost. When the guide passage 2 assumes in cross section an outwardly flaring groove-like shape, such shape facilitates separation of a mold in a molding operation of the guide passage 2 and permits guide grooves to be continuously formed at the bottoms of the intersections of the guide passage 2, which considerably reduces noise in operation.

In the guide member 20 of the engagement portion of the knife carriage 4 for engaging with the helical guide passage 2 of the drive shaft 1 to move the carriage 4 along the drive shaft 1, since the

guide member 20 has its forked portion 20a sit astride the guide passage 2 so as to cover at least one third of a circumferential length of the guide passage 2 and smoothly follows the passage 2 in operation, there is no risk that the guide member 20 drops out of the intersections of the outgoing stroke and the return stroke of the guide passage 2. In addition, since the guide member 20 has its disk portion 20b serve as a handle of the guide member 20 and rotatably supported by the knife carriage 4, it is possible for the guide member 20 to smoothly follow the guide passage 2 even when it passes through the ends of the outgoing and the return stroke of the guide passage 2, at each of which ends the knife carriage 4 may smoothly change the direction of its axial motion along the drive shaft 1.

In the sheet cutter,

the drive shaft 1 is disposed inside the hollow elongated member 3 serving as a guide rail which extends along the outgoing stroke of the guide passage 2 of the drive shaft 1. The knife carriage 4 has its engagement portion engaged with the helical guide passage 2 of the drive shaft 1 to permit the sliding portion of its engagement portion to slidably move inside the elongated member 3, so that

the knife carriage 4 moves along the length of the drive shaft 1 to cut the sheet material (not shown). Consequently, the rotating parts of the sheet cutter are not exposed to a user, therefore improving safety. In addition, it may be easily down-sized. Further, since there is no guide in an upper surface of the elongated member or guide rail 3, the sheet material to be cut is easily disposed on the upper surface of the guide rail 3 so as to be ready for its cutting operation thereon.

In the above embodiment, though the cutting operation of the sheet material is so described as to be conducted only when the knife carriage 4 travels the outgoing stroke of the guide passage 2, it is also possible to conduct the cutting operation in the return stroke of the guide passage 2. In this case, as is clear from Fig. 2, a return-stroke's end detection switch 18 is mounted on the side plate 3a to determine a time when the knife carriage 4 reaches the end of the return stroke of the guide passage 2, at which time the motor 1 is de-energized.

Now, an embodiment of the sheet cutter of the present invention in which the knife carriage 4 is

provided with a forced discharge portion 33 will be described with reference to Figs. 10 to 14.

The knife carriage 4 shown in Figs. 10 to 14 corresponds to one shown in Fig. 1, and is constructed of: an upper knife carriage 31 for rotatably supporting the first circular knife 5a; and, a lower knife carriage 32 for rotatably supporting the second circular knife 5b. Provided between the upper knife carriage 31 and the lower knife carriage 32 is a gap 4a for permitting the sheet material being cut to pass therethrough. The upper knife carriage 31 is connected with the lower knife carriage 32 through an end joint portion 31a. The lower knife carriage 32 is integrally formed with the sliding portion 41 which slides inside the hollow elongated member 3 to reciprocate the knife carriage 4 along the length of the drive shaft 1.

As shown in Fig. 10, in the sheet cutter of the present invention, the forced discharge portion 33 thereof for discharging the sheet material having been cut is provided behind a cutting position 22 at which the first circular knife 5a is brought into contact with the second one 5b. The discharge portion 33 is constructed of: a first guide surface 33a for urging a cut end of the sheet material downward to have the cut end be below a level with the cutting position 22

thereof; a second guide surface 33b for curling and discharging the cut end of the sheet material in guidance; and, a third guide surface 33c for permitting the cut end thus curled to escape to a downstream side of cutting of the sheet material. Fig. 14 shows a perspective view of the guide surface of the forced discharge portion 33 of the sheet cutter, illustrating a cross-sectional configuration of the guide surface. As shown in Fig. 14, the guide surface of the forced discharge portion 33 of the sheet cutter is defined in angle with reference to both an upper surface 301 of the elongated member 3 (hereinafter referred to as the sheet-contact surface 301) and an imaginary vertical plane 201 which passes through the line X-X of Fig. 14 so as to be perpendicular to the sheet-contact surface 301 of the elongated member 3.

As is clear from Fig. 14, the first guide surface 33a forms an angle of β = 13.9 degrees with the sheet-contact surface 301 to extend from a position 22' near the cutting position 22 downward in a downstream direction of flow of the sheet material. On the other hand, the second guide surface 33b forms a part of a substantially conical surface of a circular cone. The cone is dimensioned by giving a vertical angle of α = 20 degrees, and having its

vertex disposed at the position 22' near the cutting position 22 of the sheet material and its base disposed in the downstream side of flow of the sheet material, so that the second guide surface 33b is smoothly connected with the first guide surface 33a. The third guide surface 33c is a plane forming an angle of γ = 7.5 degrees with the imaginary vertical plane 201 which passes through the line X-X of Fig. 14, so that the third guide surface 33c extends from the position 22' near the cutting position 22 to the downstream side of flow of the sheet material and is smoothly connected with the second guide surface 33b. In other words, as shown in Fig. 14, the guide surface of the forced discharge portion 33 of the sheet cutter comprises, in combination, a flat surface, a curved surface and a flat surface, which are designated in cross section by the reference characters "e-f", "f-g" and "g-h", respectively. Due to the presence of such guide surface of the forced discharge portion 33, the sheet material has its cut end curled as it is discharged from the forced discharge portion 33 of the sheet cutter. Incidentally, though the surface "g-h" in the third guide surface 33c may be perpendicular to the sheet-contact surface of the 301 of the elongated

member 3, it is preferable to have the surface "g-h" extend slightly outward as shown in Fig. 14, which permits to utilize curvature of the sheet material in a discharging operation thereof.

In the guide surface of the forced discharge portion 33, when the angle β of the first guide surface 33a is too large, the cut end of the sheet material is excessively urged downward to have its front edge often caught in the guide surface 33a. In contrast with this, when the angle β of the first guide surface 33a is too small, such guide surface 33a fails to bring about the desired effect. Further, when the vertical angle α of the second guide surface 33b is too small, the cut surface of the sheet material assumes a wavy shape. In contrast with this, when the vertical angle α of the second guide surface 33b is too large, the cut end of the sheet material is not sufficiently curled. Further, when the angle γ of the third guide surface 33c is too small, the cut end of the sheet material can not be sufficiently spaced apart from the cutting position 22 of the sheet material. Due to this, there is a risk that the sheet material catches the knife carriage 4 reciprocating along the drive shaft 1. In contrast with this, when the angle

γ of the third guide surface 33c is too large, the end of the sheet material assumes a wavy shape. Consequently, though these angles α, β and γ depend on the quality, thickness and like parameters of the sheet material in the strict sense, it is preferable that the angle of the first guide surface 33a is within a range of from 5 to 20 degrees, that of the second guide surface 33b is within a range of from 10 to 40 degrees and that of the third guide surface 33c is within a range of from 5 to 15 degrees. Incidentally, in order to facilitate discharging of the sheet material from the sheet cutter: the lower knife carriage 32 is provided with a stepped side surface 32c; the gap 4a between the upper knife carriage 31 and the lower knife carriage 32 is enlarged in its upstream-side area between a front end 31b of the upper knife carriage 31 and that 32b of the lower knife carriage 32 so as to guide the sheet material to its cutting position 22, as shown in Fig. 10; and, an upwardly recessed portion 31c is provided in a rear end of the upper knife carriage 31 to prevent the rear end from catching in the sheet material when the knife carriage 4 returns to its rest position.

Now, in operation, the sheet cutter provided

with the forced discharge portion 33 having the above construction will be described with reference to the drawings.

Fig. 15 shows a cutting operation of the sheet material S. As shown in Fig. 15, when the sheet material S is cross-cut in a direction of the arrow X, the sheet material S at first has its cut end portion 23 hang on the cutting position 22 of the sheet material S and then separated therefrom to permit the thus cross-cut end portion of the sheet material S to be discharged from the forced discharge portion 33 in the downstream direction of flow of the sheet material S. In order to prevent the thus cut end portion 23 from interfering with the knife carriage 4, it is necessary to separate the cut end portion 23 as much as possible from the remaining part of the sheet material S. To satisfy this necessity, in prior art, there is employed a conventional discharge portion provided with an rearward recessed portion for forcibly separating the cut portion 23 apart from the remaining part of the sheet material S. However, as shown in Fig. 16, the conventional discharge portion of forcible type has the disadvantage that the cut end 25 of the sheet material assumes a wavy shape.

In general, the sheet cutter is used to cut

the sheet material supplied from a roll of the sheet material. Consequently, in most cases, the sheet material supplied by unwinding the roll thereof is kept in curl. For example, as shown in Fig. 15, when the rolled sheet material S with a radius of r is unwound and cross-cut in the direction of arrow X, the thus unwound sheet material S is kept in curl with a radius of R which is larger than the radius of r of the roll. Consequently, in Figs. 14 and 15, as the sheet material S is cut, the thus cut end or edge 23 of the sheet material S curls to form the base circle of a circular cone the vertex of which is in the cutting position 22 of the sheet material S. This finding is utilized in the sheet cutter of the present invention, in which the cut end 23 of the sheet material S is smoothly guided along the conical surface of the cone, and, therefore considerably spaced apart from the remaining sheet material's end 24. As a result, it is possible to provide a sheet cutter which is substantially free from any interference between the sheet cutter and the sheet material S and also free from the problem of the wavy shape in the cut end of the sheet material S.

In operation, the forced discharge portion 33

of the sheet cutter will be now described.

When the drive shaft 1 rotates, the knife carriage 4 having its guide member 20 guided by the guide passage 2 moves in the cutting direction indicated by the arrow X (shown in Fig. 15) so that the first circular knife 5a and the second circular knife 5b are rotatably driven through the resilient rollers 7 or O-rings 7a to have the knives 5a, 5b bite into the sheet material S, whereby the sheet material S is cross-cut. At this time, as shown in Figs. 14 and 15, since the first guide surface 33a extends downward from the position 22' toward the downstream side of flow of the sheet material S, the cut end 23 of the sheet material S is at first urged downward, then brought into contact with the conical surface of the second guide surface 33b and the third guide surface 33c which extends outward from the position 22' to form an angle γ with the vertical plane passing through the line X-X of Fig. 14. Consequently, the cut end 23 of the sheet material S smoothly follows the conical surface of the second guide surface since the sheet material S is supplied from the roll, and, therefore kept in curl as shown in Fig. 15. Then, the cut end 23 of the sheet material S is guided by the

third guide surface 33c, moved to the downstream side of flow of the sheet material S and discharged from the forced discharge portion 33 of the sheet cutter. As is clear from the above description, in contrast with the conventional sheet cutter, the cut end 23 of the sheet material S in the sheet cutter of the present invention is not forcibly separated from the remaining part of the sheet material in the forced discharge portion 33, and, therefore does not assume any wavy shapes.

As described above, in the downstream side of flow of the sheet material S in the sheet cutter provided with the forced discharge portion 33 of the present invention, there are provided: the first guide surface 33a for urging downward the cut end 23 of the sheet material 3; the second guide surface 33b for permitting the cut end 23 to curl and guiding it downward; and, the third guide surface 33c for permitting the curled cut end 23 to escape downward from the forced discharge portion 33 of the sheet cutter. Consequently, when the sheet material S, which is supplied from the roll, and, therefore kept in curl is cross-cut to produce its cut end 23, the thus produced cut end 23 is smoothly guided by the guide surfaces 33a, 33b, 33c and discharged to the

downstream side of flow of the sheet material S from the forced discharge portion 33 of the sheet cutter. Therefore, the cut end 23 of the sheet material S does not assume any wavy shapes, and is therefore excellent in productivity in the cutting operation thereof. In order to maximize their effects, these guide surfaces 33a, 33b and 33c of the forced discharge portion 33 are defined in angle so as to be within ranges of: from 5 to 15 degrees (β); from 10 to 40 degrees (α); and, from 5 to 20 degrees (γ), respectively.

In the above embodiments of the present invention, though the description has been made as to a roller-type sheet cutter provided with the first circular knife 5a and the second circular knife 5b, it is also possible to carry out the present invention in another roller-type sheet cutter in which the circular knife 5a pivoted to the knife carriage 4 is brought into slidable contact with a stationary knife fixedly mounted on the hollow elongated member 3, so that the sheet material S is cross-cut as is in the above embodiments.

As described above,

a unidirectional rotation of the drive shaft 1 enables the knife carriage 4 to

continuously reciprocate along the length of the drive shaft 1, and makes it possible to eliminate a control circuit indispensable for switching from the outgoing stroke to the return stroke of the guide passage 2 in the conventional sheet cutter, which makes it possible to reduce the number of limit switches and like components for stopping the knife carriage 4 from moving. Due to the above, it is possible to simplify the sheet cutter in construction and cut the manufacturing cost thereof. It is also possible to eliminate a noise of hitting produced at the end of the outgoing stroke of the guide passage 2 due to the carriage's inertia.

When the guide passage 2 is of an endless type, it is possible to eliminate the noise of hitting also at the end of the return stroke of the guide passage 2. Further, since the drive shaft 1 and the engagement portion of the knife carriage 4 for driving the carriage 4 are resin-molded, it is possible to easily mold the helical guide passage 2 at a low cost and to realize a further noise reduction in comparison with the conventional sheet cutter provided with a metallic

drive shaft. Further, since the helical gears are used to drive the drive shaft 1, a still further noise reduction is realized. Consequently, the sheet cutter is of a substantially noise-free type office automation instrument, and, therefore adequate to the office's needs.

Further, since the forked guide member 19 serving as an engagement member for moving the knife carriage 4 sits astride the helical groove of the guide passage 2 and is rotatably supported by the carriage 4, there is no risk that the guide member 19 drops out of the intersections of the outgoing stroke and the return stroke of the helical guide passage 2 in operation. Further, since the knife carriage 4 is smoothly transferred from the outgoing stroke to the return stroke in the guide passage 2, the cutting operation of the sheet material S is smoothly conducted. Further, since the rotating drive shaft 1 is mounted inside the hollow elongated member (i.e., guide rail) 3, any rotating components of the sheet cutter are not exposed to the user. Consequently, the sheet cutter is excellent in safety and easily downsized. In addition, in the cutting

operation, it is possible to cross-cut the sheet material S by simply disposing the sheet material S on the upper surface of the guide rail 3 in the sheet cutter.

Further, the sheet cutter is provided with the forced discharge portion 33 which is constructed of: first guide surface 33a for urging the cut end 23 of the sheet material S downward in the downstream side of flow of the sheet material S (i.e., in the discharge side of the knife carriage 4); the second guide surface 33b for permitting the cut end 23 to curl; and, the third guide surface 33c for permitting the cut end 23 to escape to the downstream side of flow of the sheet material S. Consequently, when the sheet material S still kept in curl is cross-cut, it is possible to smoothly separate the cut end 23 of the sheet material S from the remaining part of the sheet material. Consequently, the cut end 23 is free from any interference in the cutting operation of the sheet material S and does not assume any wavy shape, which enables the cutting operation of the sheet material S to be conducted in a steady manner. Due to such steadiness in operation, the sheet cutter is free from any intermittent noises

in the cutting operation, and, therefore excellent in quietness in operation. Further,

since the rotating means 7, 7a provided in the circular knives 5a, 5b enable the knives 5a, 5b to rotate and bite into the sheet material S in the cutting operation, the cutting operation is smoothly conducted.

Claims

1. A sheet cutter for cutting a sheet material by reciprocating a knife means in an outgoing stroke portion and a return stroke portion of a guide passage, comprising:

a drive shaft provided with said guide passage in its outer peripheral surface, said guide passage assuming a helical shape;

a knife carriage provided with an engagement member engaged with said helical guide passage;

said knife means being carried by said knife carriage;

a drive means for rotatably driving said drive shaft;

said guide passage being constructed with said outgoing stroke portion assuming a helical shape and said return stroke portion assuming a helical shape, said outgoing stroke portion being opposite to said return stroke portion in winding direction of said helical shape, said outgoing stroke portion having at least one of its opposite ends connected with a corresponding one end of said return stroke porion;

said guide passage of said drive shaft being resin-molded; and

said engagement member of said knife carriage being resin-molded and rotatably supported by said knife carriage.

2. A sheet cutter as claimed in claim 1, wherein:

said outgoing stroke portion and said return stroke portion of said guide passage of said drive shaft are connected with each other at opposite ends thereof so that said guide passage is formed into an endless type guide passage.

3. A sheet cutter as claimed in claim 1 or 2, wherein:

said return stroke portion of said guide passage of said drive shaft is larger in pitch of said winding than said outgoing stroke portion of said guide passage.

4. A sheet cutter as claimed in any one of claims 1 to 3, wherein:

said guide passage is constructed of a helical groove which assumes an outwardly flaring shape in cross section.

5. A sheet cutter as claimed in any one of claims 1 to 4, wherein:

said engagement member of said knife carriage is provided with a guide member which is brought into sliding-contact with said helical guide passage of said drive shaft and sits astride thereon to cover at least one third of a circumferential length of said drive shaft at its root portion or the bottom of said helical groove of said guide passage, said knife carriage being driven by said drive shaft through said sliding-contact between said guide member and said drive shaft.

6. A sheet cutter as claimed in any one of claims 1 to 4, wherein said engagement member of said knife carriage comprises:

said guide member which assumes a forked shape and is provided with a handle portion rotatably supported by said knife carriage, and a forked portion brought into sliding-contact with said helical guide passage; and

an urging means for urging said guide member of said knife carriage into said helical guide passage.

7. A sheet cutter as claimed in any one of claims 1 to 6, wherein:

said drive means for rotatably driving said drive shaft comprises a motor and helical gears which transmit

torque generated in said motor to said drive shaft.

8. A sheet cutter as claimed in any one of claims 1 to 7, wherein:

said drive shaft is mounted inside a hollow elongated member serving as a guide rail which extends along said drive shaft; and

said knife carriage is provided with a sliding portion which is brought into sliding-contact with an inner surface of said hollow elongated member.

9. A sheet cutter as claimed in any one of claims 1 to 8, wherein:

the sheet cutter further comprises a forced discharge portion provided in a back side of knife carriage; and

said forced discharge portion comprises a first guide surface for urging downward a cut end of said sheet material so that said cut end becomes lower in level than a cutting position of said sheet material, a second guide surface assuming a substantially conical surface of a circular cone having its vertex disposed in a position near said cutting position so that said cut end of said sheet material is permitted to curl and guided to its discharge area, and a third guide surface for permitting said cut end of said sheet material thus kept in curl to escape to said downstream side of feeding direction of said sheet material.

10. A sheet cutter as claimed in claim 9, wherein;

said first guide surface of said forced discharge portion of the sheet cutter comprises a plane which extends from said position near said cutting position of said sheet material to form a downward angle of from 5 to 20 degrees with a sheet-contact surface of said elongated member;

said second guide surface of said forced discharge

portion comprises a substantially conical surface of said circular cone with the vertical angle of from 10 to 40 degrees, said cone having its base disposed in the downstream side of feeding direction of said sheet material and said vertex disposed in said position near said cutting position of said sheet material; and

said third guide surface of said forced discharge portion comprises a plane which extends from said position near said cutting position of said sheet material toward the downstream side of flow of said sheet material to form an angle of from 5 to 15 degrees with a vertical plane passing through a cutting line of said sheet material;

said first, second and third guide surfaces of said forced discharge portion being smoothly connected with each other to form a guide surface for guiding said cut end of said sheet material to the downstream side of flow of said sheet material.

11. A sheet cutter as claimed in any one of claims 1 to 10, wherein:

said knife means comprises a movable circular knife rotatably mounted on said knife carriage and a substantially straight stationary knife; and

said movable circular knife is brought into sliding-contact with said stationary knife to cut said sheet material.

12. A sheet cutter as claimed in any one of claims 1 to 10, wherein:

said knife means comprises a first circular knife and a second circular knife both of which are rotatably mounted on said knife carriage; and

said first circular knife is brought into sliding-contact with said second circular knife to cut said sheet material.

13. The sheet cutter as claimed in claim 11 to 12,

wherein:

the sheet cutter further comprises a rotating means which rotatably drives at least one of said first and said second circular knife to have it bite into said sheet material when said knife carriage travels.

The Patent Office

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Application No: GB 9607795.3 **Examiner:** Hal Young
Claims searched: 1-13 **Date of search:** 3 July 1996

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B4B

Int Cl (Ed.6): B26D(1/00, 01, 04, 06, 10, 45, 60)

Other: ONLINE: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB2286788 A	(GD SpA)	
A	GB1516756	(HERMANN)	
A	US4099435	(JOHN)	

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